CLAIMS

1. A method of assessing eye function, comprising:
   (a) providing an image area in which images can be presented to the eye, and in which the luminance of any point in the image area over the desired field of view under test can be defined at least as accurately as the desired accuracy of a retinal map to be obtained;
   (b) forming a fixation image;
   (c) presenting a stimulus to the eye at a location within the image area spaced from the fixation image;
   (d) detecting a saccade triggered by said stimulus and immediately removing the original fixation image and creating a new fixation image at said location;
   (e) recording the timing and magnitude of the saccade and the subsequent fixation;
   (f) repeating steps (c) to (e); and
   (g) comparing the results with a database of typical eye responses.

2. The method of claim 1, further including determining the location of the subject's head relative to the image in at least the z-axis, without applying any constraint to the head motion.

3. The method of claim 1 or claim 2, in which each of the fixation images is an animated fixation

image comprising a substantially stationary central region comprising at least 20% of the fixation image and a mobile perimeter defined such that the perimeter is greater than 3% of the arc of vision of the test subject in diameter.

4. The method of any preceding claim, including the step of calculating the time T between the commencement of a stimulus point and the resulting saccade of the eye to said stimulus expressed by the function

Eq1:

$$T=\frac{\left(t^2 \cdot l + P\right)}{(t \cdot l)}$$

where t is the total time for the luminance "l" to integrate to the detection threshold of the retina and P is the Pullfrich delay for an arbitrarily chosen luminance "h" where h=t•l.

5. The method of claim 4, in which t is derived from the function:

Eq2:

$$\left[\begin{array}{l} \frac{-1}{(2 \cdot l)} \cdot \left(-T \cdot l + \sqrt{T^2 \cdot l^2 - 4 \cdot l \cdot P}\right) \\ \frac{-1}{(2 \cdot l)} \cdot \left(-T \cdot l - \sqrt{T^2 \cdot l^2 - 4 \cdot l \cdot P}\right) \end{array}\right] = t$$

6. The method of claim 5, in which a software algorithm is used to solve Equation 2 and use the greater of the two results as the total amplified value sensitivity of a given retinal point whereby relative sensitivity of the retina from one point to another is expressed directly as a function of t and can be derived by the software from the interval time T.

7. The method of any of claims 4 to 6, in which the intensity of "l" is adjusted to vary the resolution of the measurement.

8. The method of claim 7, in which "l" is adjusted to give an average saccade time of between 200 and 800 ms for maximum comfort and accuracy.

9. The method of any of claims 4 to 8, in which the resulting value of "t" is used directly to plot a relative sensitivity map of the retina.

10. The method of any of claims 4 to 9, in which a software algorithm is provided to translate the relative values of T to commonly used units of measure of the retinal threshold sensitivity by look up table or direct function based on the Blondel-Rey law or Bloch's law.

11. The method of any of claims 4 to 10, in which the stimulus can be increased or decreased in brightness from its initial presentation brightness during presentation, such an

increase or decrease being used to modify the function of T to t to make the resulting function either more or less linear whereby to maintain the overall test speed at a rate most comfortable to the patient.

12. The method of any of claims 4 to 11, in which several images are simultaneously presented of a resolution of less than 0.3 degrees only resolvable by the fovea, such that the eye is induced to sequentially saccade at the natural saccade frequency of the patient's natural visual scanning mode.

13. The method of claim 12, in which the value of "1" is selected to induce a saccade frequency close to the said natural scanning mode.

14. The method of any preceding claim, in which a sequence of visual stimuli is presented in said image area in a random or pseudo random sequence such that the position and preferably the expected time of appearance of the next stimulus in a sequence is not readily apparent to a person viewing the display.

15. The method of any preceding claim, in which the timing information is compared to a database of timings for a population of humans of various ages such that the integrated timings of T can be compared to an average population of the

same age as the patient under test such that the said value of T can be assigned the value of zero.

16. The method of claim 15, in which the timing information is compared with a further model of the relative normal values of integral T over the full area of the retina such that the normal variations of the retinal sensitivity with respect to angle from fovea may be corrected to zero such that any deviation from the norm will be represented as positive or negative values relative to the normal value.

17. The method of any preceding claim, in which there are displayed images containing a known priority sequence of predictable fixation points at separations of greater than 10 degrees of approximately half or less the average brightness of the image and where at least one region contains a further sub-image of a recognizable structure or alphanumeric character or pictorial representation of an object with a resolution of approximately 0.25 degrees per cycle; and in which an alarm or notification is delivered when more than one sequence of saccades of sub 100ms and greater than 10 degrees occurs per overall image and records the overall time of the sequence of sub 100mS saccades.

18. The method of claim 17, in which said image is a cartoon character, an animal picture, a vehicle, or a personality.

19. The method of claim 17 or claim 18, in which the threshold of 100mS is varied to accommodate intoxicated, brain-damaged or other abnormal patients based on an average timing of a sequence of single region of interest images as the norm for a given intoxication, brain impairment or other abnormality.

20. The method of any of claims 17 to 19, in which the images are part of a video or moving film sequence.

21. The method of claim 20, in which the initial fixation cue comprises the termination of motion of an image that induces the eye pursuit of said image.

22. The method of claim 1, in which the image contains a moving stimulus traveling across the display and where a sub-image of high detail only capable of discrimination by the fovea is presented for a period adjustable between 100-600mS within a given time of the presentation of a simple bright stimulus on the opposite point of an axis drawn through the moving stimulus, said given time being shorter than the time required by the subject to

saccade to the simple stimulus and back to the complex stimulus, preferably 50ms.

23. The method of claim 1 or claim 2, in which the first fixation image is formed by a dark area to which the eye is drawn by an image area giving an impression of perspective, and in which at least the first stimulus is formed by an image area of high spatial frequency.

24. Apparatus for use in assessing eye function, comprising:

(a) display means for presenting images to the eye where the luminance of any point in the image over the desired field of view under test can be defined at least as accurately as the desired accuracy of a retinal map to be obtained;

(b) means for generating on the display means an initial fixation image;

(c) means for generating a stimulus on the display means at a location spaced from the fixation image;

(d) means for detecting a saccade triggered by said stimulus and immediately removing the initial fixation image and creating a new fixation image at said location;

(e) means for recording the timing and magnitude of each saccade and subsequent fixation and for comparing the results with a database of typical eye responses.

25. Apparatus according to claim 24, further including means for determining the location of the subject's head relative to the image in at least the z-axis, without applying any constraint to the head motion.

26. Apparatus according to claim 24 or claim 25, in which each of the initial and subsequent fixation images is an animated image comprising a substantially stationary central region comprising at least 20% of the fixation image and a mobile perimeter defined such that the perimeter is greater than 3% of the arc of vision of the test subject in diameter.

27. Apparatus according to any of claims 24 to 26, including calculating means for calculating the time T between the commencement of a stimulus point and the resulting saccade of the eye to said stimulus expressed by the function

Eq1:

$$T=\frac{\left(t^2 \cdot 1+P\right)}{(t \cdot 1)}$$

where t is the total time for the luminance "l" to integrate to the detection threshold of the retina and P is the Pullfrich delay for an arbitrarily chosen luminance "h" where h=t•l.

28. Apparatus according to claim 27, in which the calculating means operates to derive t from the function:

Eq2:

$$\begin{bmatrix} \frac{-1}{(2\cdot l)}\cdot\left(-T\cdot l+\sqrt{T^2\cdot l^2-4\cdot l\cdot P}\right) \\ \frac{-1}{(2\cdot l)}\cdot\left(-T\cdot l-\sqrt{T^2\cdot l^2-4\cdot l\cdot P}\right) \end{bmatrix} = t$$

29. The apparatus of claim 28, in which a software algorithm is used to solve Equation 2 and use the greater of the two results as the total amplified value sensitivity of a given retinal point whereby relative sensitivity of the retina from one point to another is expressed directly as a function of t and can be derived by the software from the interval time T.

30. Apparatus according to any of claims 27 to 29, including means for adjusting the intensity of "l" to vary the resolution of the measurement.

31. Apparatus according to claim 30, in which "l" is adjusted to give an average saccade time of between 200 and 800 ms for maximum comfort and accuracy.

32 Apparatus according to any of claims 27 to 31, including means for plotting a relative sensitivity map of the retina directly from the resulting value of "t".

33. Apparatus according to any of claims 27 to 32, in which a software algorithm is provided to translate the relative values of T to commonly used units of measure of the retinal threshold sensitivity by look up table or direct function based on the Blondel-Rey law or Bloch's law.

34. Apparatus according to any of claims 27 to 33, in which the means for generating a stimulus is arranged to increase or decrease the brightness of the stimulus from its initial presentation brightness during presentation, such an increase or decrease being used to modify the function of T to t to make the resulting function either more or less linear whereby to maintain the overall test speed at a rate most comfortable to the patient.

35. Apparatus according to any of claims 24 to 34, in which the image display means is adapted to display several images are simultaneously of a resolution of less than 0.3 degrees only resolvable by the fovea, such that the eye is induced to sequentially saccade at the natural saccade frequency of the patient's natural visual scanning mode.

36. Apparauts according to any of claims 24 to 35, in which the stimulus generating means is arranged to present a sequence of visual stimuli in said image area in a random or pseudo random sequence such that the position

and preferably the expected time of appearance of the next stimulus in a sequence is not readily apparent to a person viewing the display.

37. Apparatus according to any of claims 27 to 34 including a database of timings for a population of humans of various ages, and including means for comparing measured timing information with the database such that the integrated timings of T can be compared to an average population of the same age as the patient under test such that the said value of T can be assigned the value of zero.

38. Apparatus according to claim 37, in which the timing information is compared with a further model of the relative normal values of integral T over the full area of the retina such that the normal variations of the retinal sensitivity with respect to angle from fovea may be corrected to zero such that any deviation from the norm will be represented as positive or negative values relative to the normal value.

39. Apparatus according to any of claims 24 to 38, in which the image display means is operative to display images containing a known priority sequence of predictable fixation points at separations of greater than 10 degrees of approximately half or less the average

brightness of the image and where at least one region contains a further sub-image of a recognizable structure or alphanumeric character or pictorial representation of an object with a resolution of approximately 0.25 degrees per cycle; and in which an alarm or notification is delivered when more than one sequence of saccades of sub 100ms and greater than 10 degrees occurs per overall image and records the overall time of the sequence of sub 100ms saccades.

40. Apparatus according to claim 39, in which the threshold of 100mS is varied to accommodate intoxicated, brain-damaged or other abnormal patients based on an average timing of a sequence of single region of interest images as the norm for a given intoxication, brain impairment or other abnormality.

41. Apparatus according to claim 24, in which the image display means is operative to display an image which contains a moving stimulus traveling across the display and where a sub-image of high detail only capable of discrimination by the fovea is presented for a period adjustable between 100-600mS within a given time of the presentation of a simple bright stimulus on the opposite point of an axis drawn through the moving stimulus, said given time being shorter than the time required by the subject to saccade to the simple

stimulus and back to the complex stimulus, preferably 50ms.

42. Apparatus according to claim 24 or claim 25, in which the first fixation image is formed by a dark area to which the eye is drawn by an image area giving an impression of perspective, and in which at least the first stimulus is formed by an image area of high spatial frequency.

43. A software package containing data enabling the essential timing, control and display mechanisms for carrying out the method of any of claims 1 to 23 using commercially available display, camera and measurement devices..